JOURNAL OF INTERNATIONAL REAL ESTATE AND CONSTRUCTION STUDIES, 2013
Vol 3, Issue 2, pp 1 - 27

RELATIONSHIP BETWEEN DESIGN AND BUILD SELECTION CRITERIA AND PROJECT PERFORMANCE

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ABSTRACT

One of the causes of poor project performance is the use of inappropriate procurement methods. Whilst employing an appropriate method is considered to result in project success, limited research has so far been done to empirically explore this relationship. As a contribution to addressing this gap, this paper reports on part of a wider study aimed at investigating the relationship between procurement selection criteria and key project performance outcomes (Time, Cost and Quality), towards the development of a model for explaining such relationships in detail. The aspect reported concerns the design and build (DB) procurement method, and is based on findings of a questionnaire survey. The study shows that only 9 out of the 12 common DB selection criteria have significant correlations with one or more project performance outcomes, as follows: (1) the features "speedy project execution", "client unfamiliarity with project" and "effective project planning" showed positive association with time and cost performance outcomes; (2) the features "quick project start", "low likelihood of changes", "reduced project duration" and "collaborative relationship between parties" are positively associated with time performance only; (3) the feature "high project complexity" has a positive effect on both time and quality performance, and finally (4) "reduced project cost" showed a positive relationship with only quality performance. These findings demonstrate that there is an opportunity to develop formalised regression models that can be used to predict performance based on project needs and procurement choices, to aid appropriate selection of procurement methods.

Key words: Construction procurement, procurement method, selection criteria, design and build, project performance criteria.

1. INTRODUCTION

Modern construction and engineering projects are highly complex and masked with high uncertainties (Gidado, 1996; Ericksson and Westerberg, 2011). Besides these features, projects are now increasingly subjected to strict performance demands from clients, who typically callfor contractors to deliver projects using limited resources, over a shorter durations but still to a high quality levels (Alhazmi and McCaffer, 2000; Naoum *et al.*, 2004). It has generally been extremely difficult for contractors to meet these tight requirements, judging by the high frequency at which most projects suffer from significant time and cost overruns in recent times (Ibbs *et al.*, 2003; Naoum *et al.*, 2004). A major source of the problem is often the way and manner projects are procured using the traditional form of procurement, commonly termed, design-bid-build (DBB). The DBB approach is commonly criticised for its inability to meet changing client needs and increased complexity of the interactions in technical, economic and multi-organisational participation, at play in modern project execution (Mohsini and Davidson, 1991; Love *et al.*, 1998; Ericksson and Westerberg, 2011). The response from industry towards addressing this issue has thus led to development and application of many different innovative procurement methods, including the design and build (DB), management contracting, construction management, project finance initiative and partnering, to mention but the notable ones.

The development of many alternative procurement methods has however created the problem of deciding which procurement method would be best for any given project. Clients now have to grapple with this decision problem, partly because the different methods have different features and processes of implementation (Chan and Chan, 2000; Chan *et al.*, 2001; Abdul-Rashid *et al.*, 2006), which necessitates careful consideration of the characteristics of the project at hand, if the right method is to be selected (Wardani *et al.*, 2006; Perkins, 2009). The decision-making task is also hampered by the multifarious nature of the factors to be considered and their complex interrelationship with project circumstances and requirements (Luu *et al.*, 2005). The situation is exacerbated by the fact that most clients and construction organisations lack the necessary experiential capacity required to help them make the right decision on the most appropriate procurement method (see for example, Mohsini and Davidson, 1991; Rwelamila and Edries, 2007). As a result, selection is often dictated by biased past experience and conservative choices of those methods they are familiar with, regardless of any differences in projects used on (Mohsini *et al.*, 1995; Rwelamila and Edries, 2007).

In view of the difficulties associated with deciding on the right method of procurement, research studies in the field of construction procurement have largely concentrated on the development of

scientific tools for aiding the selection process (see for example, Love *et al.*, 1998; Molenaar and Songer, 1998; Alhazmi and McCaffer, 2000; Chan *et al*., 2001; Al Khalil, 2002; Luu *et al.*, 2003; Roumboutsos, 2010). Whilst these tools are generally considered useful in bringing about sanity in procurement method selection processes, they have been criticised as being so complex, very time consuming and costly for construction organisations to implement them in practice (Chan, 2007).

Another relevant area of research relates to how aspects of particular procurement methods impact on project performance outcomes. Such research is quite important in addressing the various challenges highlighted previously, as they offer, among others, insights into aspects of procurement methods that contribute to performance enhancement. However, limited studies have so far been done in this area, with the few so far being studies on: the impact of inter-organizational conflicts in DBB process on project performance (Mohsini and Davidson, 1991; Mohsini *et al.*, 1995); the impact of change orders on cost growth in DB and DBB projects (Ibbs *et al.*, 2003; Perkins, 2009); and the influence of procurement methods on the cost of rework (Love *et al*., 1998). A common limitation of these studies is that they all focussed on the effects of only one aspect of the procurement method considered. There is therefore little research that has considered, holistically, the effect of all other relevant project delivery factors on project performance for the various procurement methods. As a contribution to addressing this gap, the aim of this paper is to explore the relationship between features of DB which influence its selection and project performance (time, cost and quality). This forms part of an on-going wider study aimed at developing a model for predicting the effects that such selection criteria have on project performance. The reason for focusing on DB procurement method is the fact that it is one of the most commonly used methods within the study area, Libya, according to the results of an earlier phase of this research (Ghadamsi and Braimah, 2012).The next section of the paper briefly discusses the methodology and research design. This is followed by a discussion on the conceptual framework that forms the theoretical basis of this research, and elaboration of the independent variables (DB selection criteria) and dependent variables (project performance criteria). An analysis of the results is then presented, with the last section of the paper outlining the key conclusions drawn from the study findings.

2. RESEARCH METHODOLOGY

The most appropriate methodology for carrying out a research is mainly dictated by the aim and objectives to be addressed. The relationships between research variables (such as those considered in this study) are best explored using a quantitative research strategy due to the ability of this approach to objectively measure the social world, test theory/hypotheses (i.e. relationships) and

predict human behaviour (Creswell, 2003).It was realised that carrying out this investigation for each of the existing procurement methods was obviously going to be too wide a scope to realistically focus on in a single study. Therefore, it became necessary early on in the study to narrow down the scope to the most common methods currently in use. Based on arguments in Gill and Johnson (2002) a qualitative research approach was considered suitable in this instance as there was little or no information about methods used in the study area.

A mixed methods research design as typically described in the literature (e.g. Tashakkori and Teddlie, 1998 and Creswell, 2003) was therefore adopted, with a dominant quantitative strategy. This research methodology consisted of a sequential exploratory strategy, as advocated by Creswell (2003), which involved in-depth interviews (qualitative) for capturing the most common procurement methods currently in use, the criteria followed in selecting them and the project performance outcomes associated with their use. The findings from this initial stage only helped to define the scope of the questionnaire survey (quantitative) for the second stage.

2.1 Survey Questionnaire Design

A questionnaire survey strategy was considered the most appropriate for the second stage data collection for a number of reasons. First, it facilitates the determination, with a known level of accuracy, of information about a large defined sample and the generalisation of the results to the study population (Rea and Parker, 1997; Burns, 2000; Gill and Johnson, 2002). It also enables comparisons of the target groups to be made on the same basis (Burns, 2000, p.567), and for this study in particular, the views of contractors, consultants and employers, were of particular interest as they are the main protagonists that deal with construction procurement issues.

Given that the survey respondents were dispersed throughout the whole country, the best way to send out the questionnaires was determined as postal mail, as internet facilities were found not reliable enough to be used to administer the survey, either via email or on-line surveys. Postal surveys are however not fool proof as they typically suffer from low response rate and difficulties of clarifying any ambiguous, incomplete or inaccurate information in the questionnaire (Rea and Parker, 1997, p.6; Burns, 2000, p.581). To address these, the questionnaire was first subjected to intense review by the authors before finalising it. As part of this review, the questionnaire was also translated from English into Arabic, the mother-tongue of the targeted respondents. In addition, two colleagues of the second author, who speak Arabic as their first language, helped in reviewing the translated questionnaire to ensure that no “different” meanings were introduced into the

questionnaire in the course of translating. Finally, as a means of testing the suitability and comprehensibility of the questionnaire, a pilot survey was carried out with 20 selected construction organisations in Libya. Comments received from this pilot study were largely positive, leading to only slight modifications to the questionnaire.

Amongst the different forms of questionnaire, the semi-structured format was used to design the questionnaire. This format has the benefit of reducing or eliminating the disadvantages of both open and closed types of questionnaires, whilst gaining their advantages (Patton, 1990; Creswell, 2003). The questionnaire therefore consisted of a combination of multiple choice questions requiring ticked-box responses and open–ended questions that required participants to present their responses in free text. The respondents were required to complete the questionnaires based on their direct experience with recently completed DB projects that they are most familiar with, as oppose to their general opinions on projects. The questionnaire was structured in 3 main sections. The first section asked general questions pertaining to details of the respondents and their organisations for data classification purposes. The second section asked respondents to rank their views (on a 5-point Likert Scale; 1 = “strongly disagree” and 5 =“highly agree”) in respect of statements on the extent to which each of12DB procurement selection criteria satisfied or were compatible with the requirements and characteristics of these past DB projects. The last part of the questionnaire asked them to rate, on a similar scale (with 1 = “low frequency” and 5 = “high frequency”), the extent by which those projects achieved their expected performance outcomes.

2.2 Sampling and Data Collection

Due to lack of specific sampling frame for construction organisations with relevant experience in procurement matters, non-probability sampling techniques (Barnet, 1991; Burns, 2000) were relied on to determine the study sample. The process involved, first, selecting a total of 200 construction organisations made up of clients, contractors and consulting firms, using a combination of quota and purposive sampling as typically described by Patton (1990) and Barnet (1991),from a database developed by the Public Project Authority (Public Project Authority, 2009), the main governmental body responsible for monitoring construction operations in Libya. This database, entitled, “Housing and Infrastructure Project Annual Report”, contains details of client, contracting and consulting organisations with significant involvement in all projects executed in the country between 2006 and 2010. The sample selection was based on two main criteria: the need to ensure that the selected firms have relevant experience and also the need for the survey outcomes to be generalizable over the study population.

The questionnaires were posted to the managing directors of the selected firms with an attached cover letter to inform recipients of the purpose of the survey, the involvement of respondents and also asking for the questionnaire to be passed onto the relevant staff member with experience in procurement method selection. After a month of sending out the questionnaires, reminders were sent to help increase the survey response rate. Of the total questionnaires sent out, only 136 questionnaires were returned of which 126 were properly completed and useful for the further analysis. This represents 68% response rate which is quite suitable since surveys with construction organizations typically achieve between 20-40% response rate (Furtrell, 1994).

3. THE RESEARCH CONCEPTUAL FRAMEWORK

The premise underlying this study follows the principle espoused in literature (for example, Mohsini and Davidson, 1991; Love *et al.*, 1998) that the best procurement method chosen for any given project based on the right procurement selection criteria would result in successful project performance. In order words, the level of performance to be expected of any project depends on the extent to which the procurement method employed was suitable for the project in question (Molenaar and Songer, 1998; Love *et al.*, 1998; Eriksson and Westerberg, 2011). On the basis of this hypothesis, it is clear that a relationship exists between the extent to which the features or selection criteria of a given procurement method are suitable or compatible with the characteristics and requirements of the project it is used for and the performance outcomes of that project. Knowledge of such relationship has the potential of providing vital insights into the relative significance of the selection criteria in influencing project performance and hence which of them should be given more attention in the procurement method selection process. To explore this relationship further, a conceptual framework (Figure 1) was established to first demonstrate the existing relationship between the research variables that are involved.

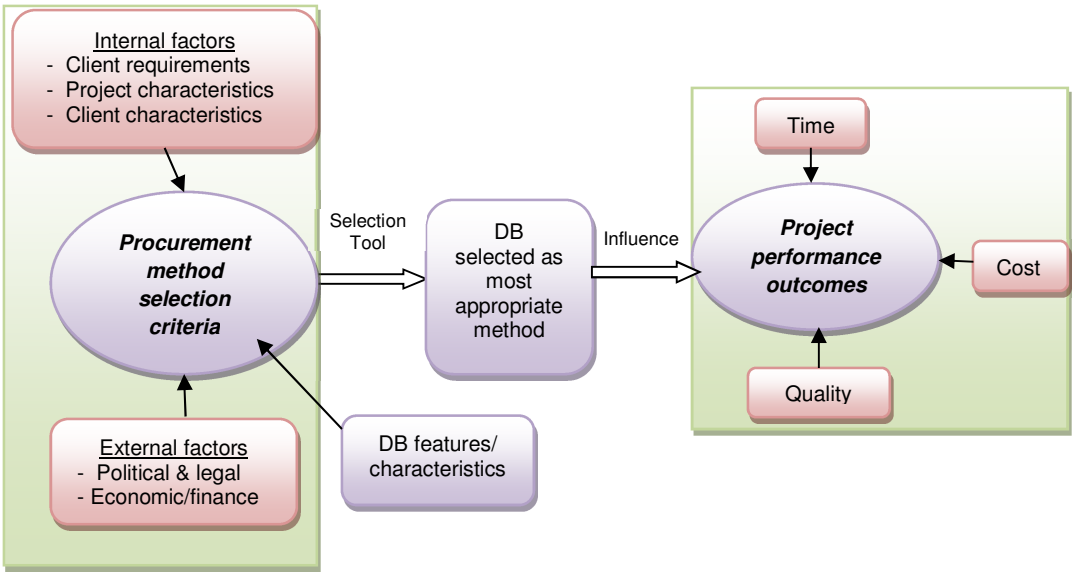

Figure 1 Procurement selection criteria and project performance - a conceptual framework

Figure 1 indicates the independent variables of the study as being represented by procurement selection criteria, whilst project performance outcomes (time, cost and quality) form the dependent variables. Review of the literature suggests that all the selection criteria emanate from two main groups of factors, namely, external environment factors (economic, political, financial and legal in nature),and internal environment factors that are classified under three main factors: project characteristics, client characteristics and client requirements (Love *et al*., 1998; Luu *et al*., 2005; Ratnasabapathy *et al.,* 2008).Based on existing procurement selection tools (see for example, Molenaar and Songer, 1998; Chan *et al*., 2001; Al Khalil, 2002), the choice of DB as the best procurement method for any given project is generally determined by first identifying from these groups the right selection criteria applicable to this method and then assessing the compatibility of the criteria in the light of the features and characteristics of the project in question. As such selection criteria have been researched extensively and documented in existing literature (for example, those listed in Table 1), it was deemed appropriate to identify the most common of the criteria through an extensive literature review. As Table 1 shows, the review resulted in the identification of 12 criteria as being the most commonly cited criteria for the appropriate selection of DB method, if increased satisfaction with project performance is to be ensured. The definition and operationalization of the identified criteria together with their relationships with project performance are discussed further under the results section.

The dependent variables of the study were restricted to project performance outcomes based on time, cost and quality criteria. Although these are commonly used to distinguish between good and poor project performance (Bryde and Brown, 2004), there are other criteria in use, such as environmental impact, health and safety, and innovation (Eriksson and Westerberg, 2011, Bassioni *et al.*, 2004; Chan *et al.*, 2001). The consideration of the additional criteria is as a result of the subjective nature by which project success is seen or measured by different project stakeholders. Jin *et al.* (2007), for instance, compared the success criteria as measured by contractors and clients, and found that clients put more emphasis on satisfying the needs of other stakeholders, while contractors emphasised on minimizing project cost and duration. Other studies have also found some consensus with all project stakeholders putting products satisfying owner's needs as their first criteria (Bassioni *et al.*, 2004; Eriksson and Westerberg, 2011). In spite of the numerous criteria or indicators that could be used to measure project performance, time, cost and quality are still considered the commonly preferred performance evaluation criteria (Bryde and Brown, 2004; Jin *et al.*, 2007). Another reason behind focusing on these alone is the fact that they are the main factors used for gauging the success of projects by stakeholders in the construction industry of the study area (Libya), as findings from an initial data collection exercise suggested (Ghadamsi and Braimah, 2012).

Table1 Criteria for selecting DB procurement method

DB Selection Criteria / Authors	*Speedy project execution desired*	*Quick project start desired*	*Effective communication among project team*	*Low likelihood of changes expected*	*Single point responsibility desired*	*Collaborative relationship between parties*	*High project Complexity*	*Client unfamiliar with project*	*Reduce project cost desired*	*Reduce project duration desired*	*Competent and experienced contractor*	*Effective project planning desired*
Ratnasabapathy*et al.* (2008)	✓	✓	✓	✓	-	-	✓	-	-	-	-	✓
Hashim*et al.* (2006)	-	-	-	-	-	-	✓	-	-	-	-	-
Sengand Yusof (2006)	✓	✓	✓	-	✓	✓	-	-	✓	✓	✓	✓
Al Khalil (2002)	-	-	-	-	✓	-	✓	-	-	-	-	-
Cheung *et al.* (2001)	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
Luu et al. (2003)	✓	✓	-	✓	-	-	✓	✓	-	-	-	-
Luu*et al.*(2005)	✓	-	-	✓	✓	-	-	✓	-	-	-	-
Love *et al*. (1998)	✓	-	-	✓	-	-	-	-	-	-	-	-
Mahon (2011)	✓	✓	✓	✓	-	-	-	-	-	-	-	✓
Hibberd and Djebarni (2010)	✓	✓	-	-	-	-	-	✓	-	-	-	-
Edmond *et al.* (2008)	-	-	✓	-	-	-	✓	-	-	-	-	-
Chan *et al.* (2001)	✓	-	✓	✓	✓	-	✓	✓	✓	-	-	-
Alhazmiand McCaffer (2000)	✓	-	-	✓	✓	-	-	✓	-	-	-	✓
Chan (2007)	-	-	-	✓	-	-	✓	✓	-	-	✓	-
Ng *et al.* (2002)	-	-	-	-	✓	-	-	-	✓	✓	✓	-
Total	10	6	5	9	7	2	8	7	3	3	4	5

4. DATA ANALYSIS

The respondents were asked to complete the questionnaires based on their experience with recently completed projects that they are familiar with. In other words, they were to objectively respond to questions on the research variables regarding those completed projects and their performance, as opposed to asking them to provide their general opinion. Generally, the respondents were to provide their views in respect of the study variables using a 5-point Likert scale. With the aid of Statistical Package for the Social Sciences (SPSS), the results obtained were analysed using descriptive statistics (frequencies), Mann–Whitney test and Spearman's rank order correlation analysis.

To enhance the validity and accuracy of the data collected, Cronbach's Alpha was used to measure the reliability of the data collection instrument employed. Cronbach's Alpha is an index commonly used to objectively measure the internal consistency of a questionnaire instrument, i.e. the extent to which all the items in a test or scale measure the same concept or construct (Bland and Altman, 1997). Cronbach's Alpha values from 0.70 to 0.95 are often taken as the acceptable range for consistency (Tavakol and Dennick, 2011; DeVellis, 2003). Table 2 shows the Alpha values for each procurement selection criteria, each of which is greater than 0.70 with an overall average value of 0.76. The results thus suggest that all the selection criteria are of high reliability, implying that each is capable of measuring the same latent trait on the same scale.

Table 2 Normality Test and Cronbach's Alpha index for DB selection criteria

DB procurement selection criteria	Kolmogorov-Smirnov[a]		Cronbach's Alpha
	df	Sig	
1 Client desiring speedy project execution	121	.000	0.721
2 Client desiring quick project start	121	.000	0.759
3 Effective communication among team required	121	.000	0.721
4 Low likelihood of changes expected	121	.000	0.741
5 Client desiring single point responsibility	121	.000	0.749
6 Collaborative relationship between parties	121	.000	0.735
7 High level of project complexity	121	.000	0.782
8 Client unfamiliar with project	121	.000	0.776
9 Client desiring reduced project cost	121	.000	0.744
10 Client desiring reduced project duration	121	.000	0.740
11 Competent and experienced contractor	121	.000	0.755
12Client desiring effective project planning	121	.000	0.745
The overall Cronbach's Alpha α			**0.761**

Prior to the statistical analysis, the data was first subjected to the test of normality to ascertain whether the distribution of data is normal or not. The Kolmogorov-Smirnov test was used for this test as it is one of the commonly used approaches for testing for departures from normality (Stephens, 1986). A distribution is considered significantly different from a normal distribution if the test values obtained are significant with $p < 0.05$, and vice versa. As can be seen in Table 2, each procurement selection criteria has $p < 0.05$ values, suggesting that the distribution of the study data does not follow that of a normal distribution. The non-normal nature of the data confirms the use of non-parametric statistics (such as those listed in the previous paragraph) as the best method for analysing the results (Siegel and Castellan Jr., 1988).

5. RESULTS AND DISCUSSIONS

5.1 Respondent and their organisation details

Out of the 126 responses, 45% came from client organisations, 35% from contractor organisations and the remaining 20% were from consulting firms. Table 3 gives detailed breakdown of the questionnaires responses as obtained from only client and contractor organisations, since the focus of this paper is limited to the perceptions of these two groups.The table also shows the designations of the respondents, which indicates a wide range of different roles of specialty with majority serving as project managers.

Table 3 Breakdown of Response

Types of Construction Organization	Respondent Role/Designation	Response frequency	Percent (%)
Client Organisation	Project manager	15	11.9
	Site engineer	6	4.8
	Quantity surveyor	11	8.7
	Design engineer	11	8.7
	General supervisor	10	7.9
	Architecture engineer	6	4.8
Construction Firm	Project manager	14	11.1
	Site engineer	10	7.9
	Quantity surveyor	6	4.8
	Design engineer	4	3.2
	General supervisor	7	5.5
	Total	100	80%

The respondents were asked to indicate their years of experience as far as working in the Libyan construction and civil engineering industry is concerned. As shown in Figure 2, majority of the respondents (30%) have between 21-25 years of experience, followed by respondents with 11-15 years of experience (20%), and then those with 16-20 years of experience (19%). This high percentage of respondents with many years of experience (at least 11 years), suggests that the respondents were experienced enough to respond or comment on the issues investigated in this study.

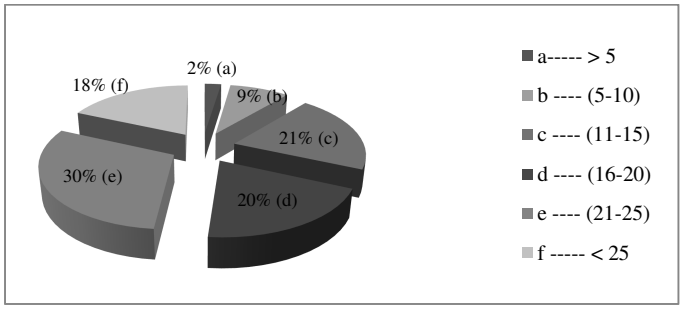

Figure 2 Years of experience of the respondents

Another important respondent detail investigated was the type of projects respondents' organisations are involved in. The response obtained for this are as presented in Figure 3, which shows that nearly half of the respondents are involved with building projects whereas 15% are involved with buildings and roads project and 14% involved with roads projects.

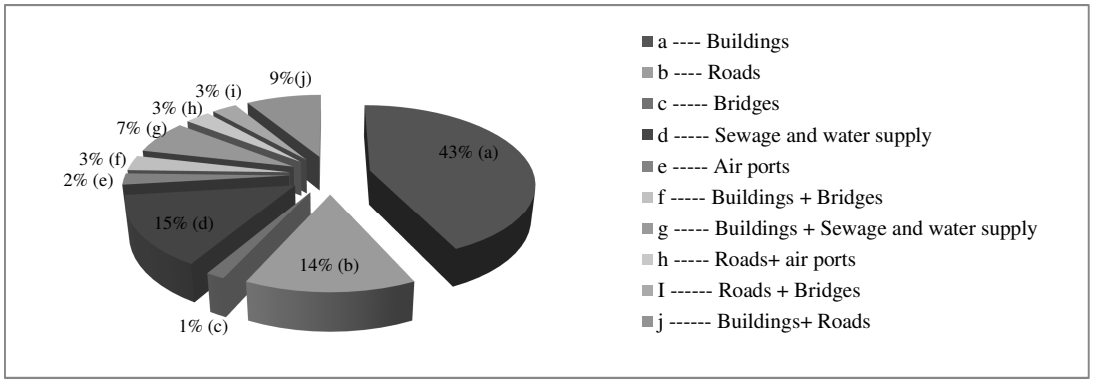

Figure 3 Type of projects engaged by respondents' organisations

5.2 Influence of selection criteria on the choice of DB procurement method

An important aspect of the research inquiry involves investigating the extent to which procurement selection criteria informed the procurement method selection process. The respondents were thus asked to rank the extent to which each of the selection criteria matched (or compatible with) the characteristics/requirements of the past DB projects, using a scale of 1-5, where 1 represents "Strongly Disagree" and 5 represents "Strongly Agree". Respondents were also asked to add and rank any other additional criteria that they consider relevant but were not among the list of common selection criteria. Figure 4 shows the results obtained, which indicates the average level of agreement as being greater than 3 for all the criteria.

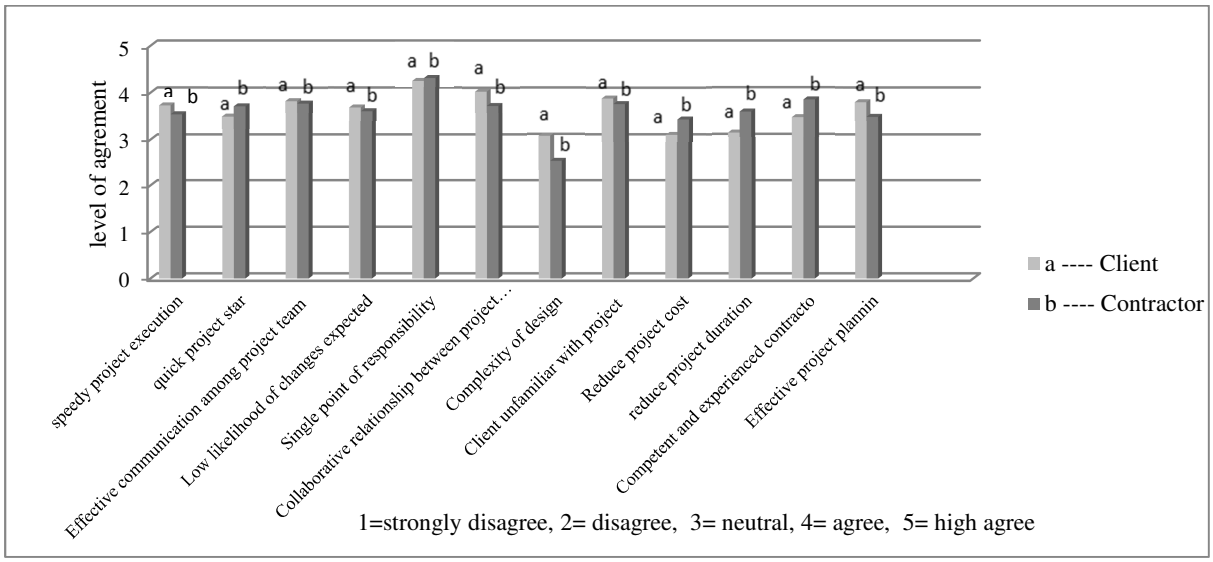

Figure 4 Extent of agreement on the matching of procurement selection criteria with DB projects

Mann-Whitney U Test was also conducted to determine how statistically significant the differences between clients and contractors are (see results in Table 4). As can be seen, the test values of the selection criteria are not statistically significant at p value < 0.05, which suggests that there are no significant differences in the scores assigned to each of the selection criteria by the two responding groups. In order words, the null hypothesis that there is no real difference between client and contractor groups in their rating of the selection criteria is to be accepted.

Table 4 Statistical significant of DB procurement selection criteria

Procurement selection criteria	Z	Probability, *p*
1-Client desiring speedy project execution	-1.537	.198
2-Client desiring quick project start	-1.152	.237
3- Effective communication among team required	-1.254	.161
4- Low likelihood of changes expected	-0.416	.671
5- Client desiring single point responsibility	-0.329	.765
6- Collaborative relationship between parties	-0.722	.535
7- High level of project complexity	-0.592	.476
8- Client unfamiliar with project	-0.305	.823
9- Client desiring reduced project cost	-0.275	.699
10- Client desiring reduced project duration	-0.073	.774
11- Competent and experienced contractor	-0.080	.980
12- Client desiring effective project planning	-0.201	.0792

5.3 Influence of DB on project performance

To explore the influence that DB have on project performance outcomes, the respondents were asked to indicate the extent by which past DB projects they are familiar with did achieve their expected performance outcomes of time, cost and quality, using a scale of 1 to 5; 1 representing “very low frequency” and 5 represent “very high frequency”. In order to ensure a valid link between DB and project performance, respondents were asked to discount the effect of other factors that did not form part of the features/characteristics of DB in their responses. Figure 5 shows the results obtained, which indicate that there is moderate extent by which DB projects are able to achieve time, cost and quality performance as depicted by an average value of 2.6, 2.6 and 2.7 respectively.

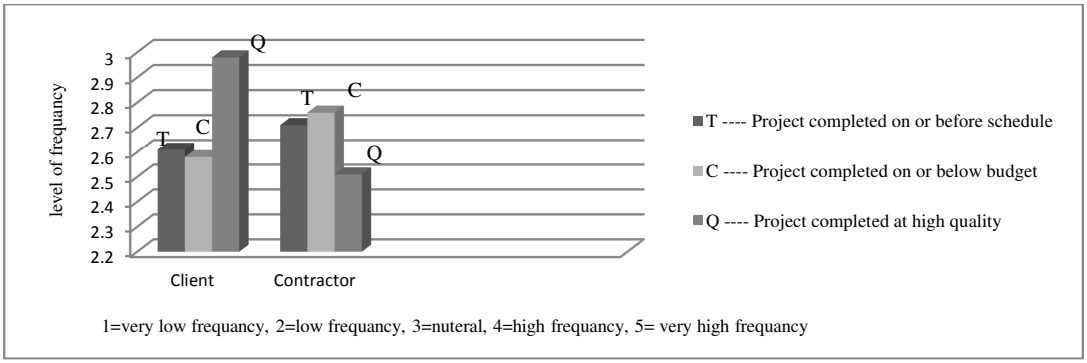

Figure 5 Extent by which performance outcomes are achieved in DB projects

5.4 Relationship between procurement selection criteria and project performance

The method used to determine the relationship between procurement selection criteria and project performance was Spearman's rank order correlation for non-parametric data. This method was applied to the data plotted in Figures 4 and 5. This analysis was carried out with the main aim of exploring the linear association between the project performance outcomes for DB (as outputs or dependent variables) and the ordinal-scaled procurement selection criteria (as inputs or independent variables). A summary showing the significant results obtained is presented in Table 5.

Table 5 Correlation between procurement selection criteria and DB project performance

Procurement selection criteria	Statistics	Project performance outcome		
		Time	Cost	Quality
Client desiring speedy project execution	Correlation Coeff.	.287 **	.224 **	-
	Sig.	.001	.012	-
Client desiring quick project start	Correlation Coeff.	.296 **	-	-
	Sig.	0.002	-	-
Client unfamiliar with project	Correlation Coeff.	. 275 **	.297 **	-
	Sig.	0.002	.006	-
Low likelihood of changes	Correlation Coeff.	. 249 **	-	-
	Sig.	.005	-	-
High level of project complexity	Correlation Coeff.	-.186 **	-	.248 **
	Sig.	.037	-	.005
Client desiring reduced project cost	Correlation Coeff.	-	-	.190 **
	Sig.	-	-	.033
Client desiring reduced project duration	Correlation Coeff.	. 231 **	-	-
	Sig.	.009	-	-
Collaborative relationship between parties	Correlation Coeff.	. 233 **	-	-
	Sig.	.009	-	-
Client desiring effective project planning	Correlation Coeff.	.201 **	.176 *	-
	Sig.	.024	.049	-

Like any correlation exercise, the strength of the associations were measured in terms of coefficients on a ±1 continuum; with +1 representing a perfect positive association, -1 a perfect negative association and 0 representing no association. In line with the commonly applied threshold for testing statistical significance, coefficients with $p < 0.05$ values indicate the existence of statistically significant correlation, and vice versa. As can be seen in Table 5, only 9 of the 12 selection criteria exhibited significant correlation with one or more of performance criteria for projects delivered by DB in Libya. These relationships are summarised in Figure 6 and discussed in detail in the sections following.

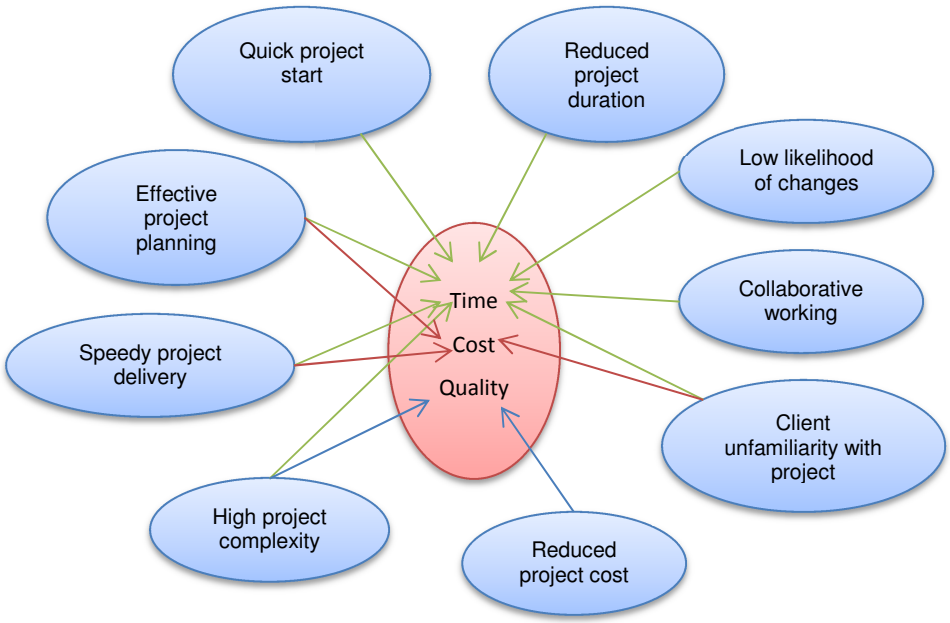

Figure 6 Selection criteria that showed significant correlation with project performance

5.4.1 Client desiring speedy project delivery

Delays and protracted project schedule have huge risk implications for all parties involved in project execution. As such, a common demand from clients often includes the need to fast-track the project delivery process. The essential elements of fast-tracking include: overlapping of functions and development stages through concurrent engineering (Bogus *et al.*, 2005); and commencing construction prior to the completion of all design activities and subcontractor selection (Molenaar and Songer, 1998). Based on these features, this criterion was operationalized as the extent to which the actual construction of projects was able to begin whilst the design, plans and specifications were still developing and not complete. The findings show significant positive correlation between this criterion and time and cost performance criteria. This reflects earlier research findings concerning the advantages of DB, including its ability to compressed project schedule by running design and

construction phases concurrently to ultimately help reduce cost of the project (Mohsini *et al.*, 1995; Edmond *et al.*, 2008; Perkins, 2009). Another feature that explains this positive correlation is the fact that DB process facilitates good communication and management of the information flow between construction and design team members, which is considered as the linchpin of effective fast-tracking of projects (Molenaar and Songer, 1998; Bogus *et al.*, 2005).

5.4.2 Client desiring quick project start

As typical of any project, clients sometimes would want their projects commenced earlier than originally anticipated, for reasons related to economic, business and political uncertainty among other things. This criterion was thus operationalized based on the extent to which the client preferred early commencement of projects. The results indicate significant positive correlation between this criterion and the time component of project performance. An obvious explanation for this finding is the fact that DB method allows for construction to start before design is completed and hence there is a much higher likelihood of achieving good performance in terms of overall project time duration (Love *et al*., 1998; Edmond *et al.*, 2008).

5.4.3 Client unfamiliarity with project

Under DB procurement method, contractors tend to be selected relatively early based on the project brief or outline drawings, with the detailed design afterwards being the contractor's responsibility (Molenaar and Songer, 1998; Eriksson and Westerberg, 2011). For this reason, clients with limited knowledge of detailed design requirements tend to favour this method, making this criterion an important consideration for the selection of DB procurement method. This criterion was thus operationalized on the basis of the extent to which clients of past projects were unfamiliar with detailed design requirements. The results show that this criterion has a significant positive correlation with time and cost performance criteria. Being less familiar with the project diminishes the level of interference or influence clients can exert on the project design and specifications, and thus offers the contractor more leeway with the design, thereby enhancing constructability and innovation, which in turn facilitates cost savings and reduced project duration (Molenaar and Songer, 1998; Eriksson and Westerberg, 2011).

5.4.4 Low likelihood of changes

Changes (or variations) are a common feature of construction projects which tend to affect project performance negatively (Ibbs *et al.*, 2003). The impact on performance to be expected is a factor of how flexible the changes could be effected or accommodated, which mainly depends on the stage of the project, complexity of the project, design process and coordination of activities (Ng *et al.*, 2002; Edmond *et al.*, 2008). In view of these factors, different procurement methods are expected to experience different effects from changes (Perkins, 2009). This criterion was thus operationalized as the extent to which the past DB projects did experience low level of design and construction changes. The study found positive significant correlation between this criterion and the time component of project performance but registered no association with the other two performance criteria (quality and cost). The DB method has two significant advantages that could explain the basis of this correlation. First, the method is capable of eliminating or significantly reducing design errors, which often constitute a major source of change to construction contracts (Love, 2002; Perkins, 2009). This can lead to reduced number of changes with little or no time to be spent on resolving design errors, allowing the contractor to focus more on the actual works and keep up with progress without delays. Secondly, by virtue of the integration between design and construction phases, the designer and the contractor often work closely together, which enable them to use their skills to reduce construction time (Molenaar and Songer, 1998; Perkins, 2009).

5.4.5 Project complexity

Project delivery is often characterised by complicated processes and high uncertainties (Mohsini and Davidson, 1991; Gidado, 1996). A key feature of complexity is high interdependency between project activities, which require among others a central coordinating unit for dealing with the issues involved (Mohsini, *et al*., 1995). In view of these characteristics, this criterion was conceptualised as the number of different project activities (and their relationships) that define the whole project scope from design through to end of construction. As Table 5 shows, the study demonstrates a significant positive correlation (at $p<0.05$) between this criterion and the time and quality components of project performance criteria. The findings were not unexpected as existing literature suggests this criterion as one of the key factors to be considered in the appropriate selection of DB for a project if improved project performance is to be ensured (Molenaar and Songer, 1998; Hashimet al., 2006; Chan, 2007). There was however no correlation between this criterion and the performance criteria of cost although some studies suggest otherwise (Love et al., 1998; Cheung et al., 2001).

5.4.6 Client desiring reduced project cost

Previous studies have emphasized that DB provides better value for money (Molenaar and Songer, 1998; Eriksson and Westerberg, 2011), which explains why this criterion is often considered as one of the DB selection factors. This criterion was thus operationalized as the extent by which clients were keen to ensure reduction in project cost. It was found from the study results that this criterion positively correlates with only quality performance outcome, with no correlation with time and cost. This positive association with quality can be explained from the fact that the DB procedure facilitates increased coordination and integration between designers and contractors, thereby increasing the project's buildability (Love *et al.*, 2002; Eriksson and Westerberg, 2011). Buildability has the potential of decreasing the risk of defective design and hence reduction in the number of rework to be expected, which in turn contributes to high quality of completed works.

5.4.7 Client desiring reduced project duration

Different procurement methods are characterised by different processes and procedures with associated time durations, resulting in them having different procurement cycles (Molenaar and Songer, 1998; Perkins, 2009; Eriksson and Westerberg, 2011). Thus clients looking to achieve savings in time on their projects often consider this criterion when selecting procurement method. This criterion was operationalized as the extent of clients' desire to finish projects by an earlier completion date or shorten project duration. The results show significant positive correlation between this criterion and project performance in terms of time only. This is to be expected given that DB projects have a single procurement cycle by virtue of the fact that a "single phase" is used to procure both the design and construction activities, resulting in substantial savings in time as highlighted by many researchers (see for example, Edmond *et al.*, 2008; Perkins, 2009; Eriksson and Westerberg, 2011).

5.4.8 Collaborative working relationships

The traditional approach (DBB)to delivering construction projects is often blamed for the adversarial attitude and relationship between contracting parties (Mohsini and Davidson, 1991; Alhazmi and McCaffer, 2000; Ibbs*et al.*, 2003). The need to reduce this adversarial culture and its associated high level of disputes has been a major drive behind the introduction of new procurement methods such as DB (Tang *et al.*, 2006; Edmond *et al.*, 2008). This criterion was thus operationalized on the basis of the extent to which project team members did collaborate with each other on work execution for the past DB projects. As the results show, there is a significant positive correlation between this

criterion and the time component of project performance outcome only. This finding is quite understandable because running of design and construction operations concurrently in DB calls for better coordination and collaborative relationship amongst project team members (Love *et al*., 1998; Edmond *et al*., 2008), thereby contributing to fast project delivery (Bogus, *et al.*, 2005; Tang *et al.*, 2006).The finding corroborates the results of some past research in which positive association was also exhibited between this criterion and other performance criteria, namely, cost and quality (Yang 2007; Eriksson and Westerberg, 2011), environmental performance (Cole, 2000; Shen and Tam, 2002) and innovation (Alderman and Ivory, 2007; Eriksson and Westerberg, 2011).

5.4.9 Client desiring effective project planning

Various studies suggest that clients' objectives in construction projects can be better achieved through improving the efficiency of the construction planning process (Faniran *et al.*, 1994, Naoum *et al*., 2004; Gidado, 2004). The key factors that contribute to ensuring effective planning have been identified from research (see e.g. Faniran *et al*., 1994) as increased formalisation, decrease centralisation and increased specialisation. Earlier studies have also established that construction planning efforts are influenced by organisational characteristics of construction firms (Kabasakal *et al.*, 1989; Gidado, 2004). These organisational features are directly influenced by the procurement methods used, with DB likely to promote more efficient construction planning due to having more collaborative arrangements in place for planning, design and construction works (Edmond *et al.*, 2008; Eriksson and Westerberg, 2011).This criterion was thus operationalized based on the extent to which the client was desirous to ensure that effective construction planning was achieved. The study found a significant positive correlation between this criterion and time and cost performance outcomes. There are a number of DB characteristics that go to explain why this criterion exhibited such positive effect on project performance. For instance, in DB, the designer and the contractor work closely together to facilitate proper development, implementation and management of the construction plan (Molenaar and Songer, 1998; Eriksson and Westerberg, 2011). In addition, it is worth noting that effective construction planning rests very much on a company's ability to collect information and transmit them effectively to those concerned (Faniran *et al*., 1994), and also in making sure that plans are prepared by those responsible for implementing them (Faniran *et al*., 1994; Ballard and Howell, 1998; Barber *et al.*, 1999), meaning that more successful delivery is likely to result from effective planning.

5.5 Selection criteria exhibiting no significant correlation with performance

"Single point responsibility desired", "Effective communication among project team", and "Competent and experienced contractor" are the only three DB selection criteria that show no significant correlation with the project performance outcomes, although literature suggests (see Table 1) they are all important factors to be considered in deciding on DB method.

For "Single-point responsibility", the key rationale behind clients desiring this criterion is that, it makes it possible for them to draft contracts that guarantee performance from the contractor. It also makes it possible for clients to prove negligence relatively easier than would otherwise have been the case involving many parties (Ive and Chang, 2007). This criterion was thus operationalized as the extent to which clients were desirous to allocate responsibility for damages suffered, on account of the project going wrong. The non-significant correlation observed between this criterion and project performance probably indicates that Libyan DB projects tend to experience less need or desire to establish responsibility for damages incurred from problems encountered.

Effective communication plays a crucial role in ensuring good project performance, irrespective of the type of procurement method to be used (Mohsini and Davidson, 2001). Unlike DBB method which, by virtue of its separate design and construction roles, tends to inhibit communication flow amongst project team, the DB, on the other hand, creates minimal obstacles to information flow (Love, 2002). The non-significant correlation exhibited between this criterion and project performance was therefore a surprising outcome. This finding could mean that communication effectiveness does not feature as a significant issue of concern for DB project execution in Libya.

As DB projects require the contractor to undertake both design and construction responsibilities which are often sophisticated in nature (Love *et al.*, 1998), the level of experience and competency of available contractors are often considered by clients as important factors for deciding on the suitability of this method (Molenaar and Songer, 1998). The non-significant correlation between this criterion and project performance was therefore a surprise. This finding probably suggests that Libyan DB projects in the past were not sophisticated enough to warrant the need for clients to give serious consideration to the level of experience and competency of bidding contractors.

6. STUDY LIMITATIONS

Like with any research, this study has its own limitations. First, the subjective nature of the research variables could be misinterpreted by respondents based on their own understanding of what each variable means. To address this risk, a glossary of definitions for each variable and how they should be measured using their operational or proxy variables was enclosed in an appendix to the questionnaire for their reference. Another limitation is that the study data came from the respondents' personal assessment of their experience of past projects as opposed to data from actual existing records of these projects. This subjectivity of the respondents' responses was however directed towards specific projects that they participate actively in their procurement selection and delivery, but not applied to a hypothetical situation. In spite of these limitations, the study results have significant implications on the selection process of DB method and also set the basis for pursuing the further research of which this study forms part of.

7. CONCLUSION

In general, the project findings contribute new knowledge and insights into how DB procurement selection criteria influence project performance, which are quite useful and have important implications for the selection of construction procurement methods. First, the study provides information on the key DB procurement method selection criteria that are significant in influencing the performance of projects procured by the method. Such information offers construction professionals involved in procurement selection knowledge of which of the selection criteria need more attention, which would not only facilitate a quick and efficient DB procurement selection process, but also has the potential of increasing the chances of project success. Second, the identified significant selection criteria can also be used to predict the likely contribution that DB method could have on project performance. This predictive aspect of the research is yet to be developed (based on a formalised regression model) in the next phase of the authors' research. Such a model would help to determine the extent by which each of the key criteria are deficient in terms of their contribution to ensuring success of a project and hence the best ways to enhance them if project performance is to be improved.

Although the study was carried out based on projects executed in Libya, the procurement selection criteria and success criteria identified and investigated are all relevant to projects elsewhere. Coupled with the similar culture and attitude of practitioners believed to prevail in countries within that sub-region, it is reasonable to assume that the study findings may also be applicable to similar countries.

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